

WHAT IS CLAIMED IS:

- 1 1. A method of generating a graphical bar code, comprising
2 halftoning regions of an original image incorporating errors diffused among
3 regions of the original image and computed based at least in part upon modulations
4 in the graphical bar code corresponding to a graphical encoding of a message.
- 1 2. The method of claim 1, wherein halftoning comprises computing
2 quantization errors for respective regions of the graphical bar code.
- 1 3. The method of claim 2, wherein the computed quantization errors are
2 invariant to the graphically encoded message.
- 1 4. The method of claim 3, wherein average block errors are diffused
2 among regions of the original image.
- 1 5. The method of claim 2, wherein halftoning comprises modifying
2 original image regions with diffused errors to produce corresponding regions of a
3 modified original image.
- 1 6. The method of claim 5, further comprising applying a matrix-valued
2 error filter to compute quantization errors to be diffused.
- 1 7. The method of claim 5, wherein quantization errors are computed
2 based at least in part upon a comparison of regions of the modified original image
3 with corresponding regions of the graphical bar code.
- 1 8. The method of claim 5, further comprising quantizing regions of the
2 modified original image to produce corresponding regions of a base image.
- 1 9. The method of claim 8, wherein quantizing comprises thresholding
2 regions of the modified original image.

1 10. The method of claim 9, wherein regions of the modified original image
2 are thresholded at an intermediate gray level.

1 11. The method of claim 8, wherein quantizing comprises assigning to
2 regions of the base image respective representative quantized regions selected from a
3 subset of possible representative halftone regions.

1 12. The method of claim 11, wherein the subset of possible representative
2 quantized regions consists of an all-dark representative quantized region and an all-
3 bright representative quantized region.

1 13. The method of claim 8, wherein regions of the base image are
2 modulated with a graphical encoding of the message to produce corresponding
3 regions of the graphical bar code.

1 14. The method of claim 1, further comprising generating a sequence of
2 graphical code words corresponding to a graphical encoding of the message.

1 15. The method of claim 14, wherein halftoning comprises generating
2 regions of a base image based upon propagation of errors to corresponding regions of
3 the original image, and further comprising modulating regions of the base image
4 based upon the sequence of graphical code words to produce corresponding regions
5 of the graphical bar code.

1 16. The method of claim 15, wherein modulating base image regions
2 comprises applying an invertible graphical operation between regions of the base
3 image and graphical code words.

1 17. The method of claim 14, wherein one or more of the graphical code
2 words are non-information-encoding and the remaining graphical code words are
3 information-encoding.

1 18. The method of claim 17, wherein ~~information encoding graphical code~~
2 words and non-information encoding graphical code words are distinguishable on
3 the basis of average gray value.

1 19. The method of claim 18, wherein information-encoding graphical code
2 words have gray values within a selected gray value range.

1 20. The method of claim 17, wherein one or more non-information
2 encoding graphical code words do not encode modulations into the graphical bar
3 code during encoding.

1 21. The method of claim 17, wherein one or more non-information
2 encoding graphical code words visually enhance regions of the graphical bar code
3 when encoded.

1 22. A computer program for generating a graphical bar code, the computer
2 program residing on a computer-readable medium and comprising computer-
3 readable instructions for causing a computer to:

4 halftone regions of an original image incorporating errors diffused among
5 regions of the original image, and ~~computed~~ based at least in part upon modulations
6 in the graphical bar code corresponding to a graphical encoding of a message.

1 23. A method of decoding a graphical bar code, comprising:
2 generating a base image having halftone regions representative of an original
3 image;
4 probabilistically comparing regions of the base image to a set of graphical
5 code words to obtain a sequence of graphical code words corresponding to a
6 graphical encoding of a message; and
7 decoding the sequence of graphical code words to produce a decoded
8 message.

1 24. The method of claim 23, wherein the base image is generated by
2 halftoning regions of the original image incorporating errors diffused among regions

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3 of the original image and computed based at least in part upon modulations in the
4 graphical bar code corresponding to a graphical encoding of a preselected message.

1 ~~25. The method of claim 24, wherein the diffused errors are invariant to~~
2 the graphically encoded message.

1 26. The method of claim 23, wherein the base image is generated without
2 foreknowledge of the original image.

1 27. The method of claim 26, wherein generating the base image comprises:
2 measuring one or more intrinsic features of the graphical bar code; and
3 based upon the intrinsic feature measurements, selecting a sequence of
4 halftone regions from a preselected set of halftone regions permitted to represent
5 regions of the original image.

1 28. The method of claim 27, wherein selecting the sequence of
2 representative halftone regions comprises selecting a representative halftone region
3 for each region of the graphical bar code likely to match a corresponding region of
4 the base image.

1 29. A computer program for decoding a graphical bar code, the computer
2 program residing on a computer-readable medium and comprising computer-
3 readable instructions for causing a computer to:
4 generate a base image having halftone regions representative of an original
5 image;
6 probabilistically compare regions of the base image to a set of graphical code
7 words to obtain a sequence of graphical code words corresponding to a graphical
8 encoding of a message; and
9 decode the sequence of graphical code words to produce a decoded message.